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Research Application Summary

Natural regeneration of Heglig [*Balanites aegyptiaca* (Del.)] in the dry region of Sudan

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Abstract

Balanites aegyptiaca is a promising widely distributed tree of high economic, social, and environmental value. However, its existence is threatened. The objective of this study was to assess the natural regeneration of *B. aegyptiaca* in the dryland of Sudan. Natural regeneration of *B. aegyptiaca* was monitored in the field at different sites, immediately after the rainy season. Those sites were abandoned agricultural farms, natural forests, vicinity of villages, valleys (seasonal water courses) and karab (eroded site). Random samples with 50 m in diameter each were laid on the northern, middle and southern skirt of various locations in each of the site. Height and diameter of sample trees were recorded. Any *B. aegyptiaca* plant measuring 2.5 cm and less in diameter and height 1.3 m or below was considered as seedling. Results revealed that the natural regeneration of B. *aegyptiaca* was continuous in all sites except in the village vicinity. The stocking density was more than fair in most sites, specially the abandoned agricultural farm (1375 plant/ha), but scanty along valley meander and banks (135 -290 plant/ha). It was concluded that if attention could be given to conservation and management of B. *aegyptiaca* stands, the tree species would survive as the natural regeneration is abundant. A planting programme is therefore not required.

Key words: Management program, monitoring of regeneration, stocking density, site

Résumé

Balanite aegyptiaca est un arbre prometteur largement répandu de grande valeur économique, sociale et environnementale. Cependant, son existence est menacée. L'objectif de cette étude était d'évaluer la régénération naturelle de *B. aegyptiaca* dans les zones arides du Soudan. La régénération naturelle de B. aegyptiaca a été suivie sur le terrain sur différents sites, immédiatement après la saison des pluies. Ces sites étaient des fermes agricoles abandonnées, des forêts naturelles, des abords de villages, des vallées (cours d'eau saisonniers) et des karab (site érodé). Des échantillons aléatoires de 50 m de diamètre chacun ont été posés sur la jupe nord, médiane et sud de divers endroits de chacun des sites. La hauteur et le diamètre des arbres échantillonnés ont été enregistrés. Toute plante de *B. aegyptiaca* mesurant 2,5 cm et moins de diamètre et de hauteur 1,3 m ou moins était considérée comme un semis. Les résultats ont révélé que la régénération naturelle de *B. aegyptiaca* était continue dans tous les sites sauf dans les environs du village. La densité de peuplement était plus que correcte dans la plupart des sites, en particulier la ferme agricole abandonnée (1375 pieds / ha), mais peu abondante le long des méandres et des berges de la vallée (135-290 pieds / ha). Il a été conclu que si une attention pouvait

être accordée à la conservation et à la gestion des peuplements de *B. aegyptiaca,* les espèces d'arbres survivraient car la régénération naturelle est abondante. Un programme de plantation n'est donc pas nécessaire.

Mots clés : programme de gestion, suivi de la régénération, densité de peuplement, site

Background

Forest cover in Sudan was estimated at 12% in 2011 (SMI, 2011). This low value is a consequence of expansion in agriculture, wood harvesting and free grazing accelerated by high variability of rainfall. Several decrees were issued in Sudan to protect and ban the cutting of endangered trees; among them is *Balanites aegyptiaca* (Warag *et al.*, 2002). Extensive extension campaigns were conducted during the 1980s and 1990s to sensitise local people on the dangers of cutting B. *aegyptiaca* trees.

The dryland in Sudan represents 59% of the total area of the country stretching from east to west between latitude 10° and 23º N. It is characterized by scanty and erratic rainfall, prolonged dry season, high temperature and high evapotranspiration (Mustafa, 1997). Drought is frequent in the dryland due to fluctuations in rainfall and temperature. The main victims of the drought are the natural resources, especially forest cover which is the main source for food and fodder during dry periods. In the dryland, *B. aegyptiaca* grows in association with Acacia seyal on cracking clay soil (El Amin, 1990). It is also found on the slopes and foot of rocky hills and fringes of iron stone regions (Hall, 1992). It is indigenous to all dry lands south of the Sahara, and extends south ward to Malawi (NRC, 2008). The tree is common in cracking clay soil under 500 mm rainfall and more. The species has been subjected to continuous felling to meet peoples demand for fuel wood, building and fencing poles, timber for furniture and crop cultivation.

Natural regeneration remains the important process in plant succession The persistence of seeds in the soil depends on many factors such as decay, pathogens, predation and rainfall that affect germination or depletion. However, rainfall is known to play the major role role (Mustafa, 1997). It was reported that natural regeneration could be successful where native seedlings develop good roots, with less disturbance to soil ecology and reduction of risk to soil erosion (Kirkpatrick *et al.*, 2010). The low rate of seed production, exhaustion of the soil seed bank, unfavorable hydrological or microclimatic conditions with human and livestock pressure would limit and slow down the recovery of natural dry land forests (Mustafa, 1977). Fire playa a basic role in determining natural regeneration dynamics by disturbing the soil seed bank. Light is the most important environmental factor affecting the processes of seedling recruitment and attribution in tropical forests. Seeds need more light than they receive in the forest understory to recruit new individuals. Interactions with other plants and animals, climate and disturbances like fire or landslides, are limiting factors in any restoration success. Water is a determining factor in successful natural regeneration. It is required for seed germination, growth and development. Gaps with irregular shapes, in general, have more pronounced gap-edge effects on the inner-gap environment because of increased competition for both aboveground (light) and belowground (water, nutrients) resources (Gagnon, 2004). Generally, the environment within a gap is heterogeneous and it would influence regeneration of different species through seed lodgment, germination or survival of the seedlings.

Rationale and objective of the study

Natural forests in developing countries and in the savannah region of the Sudan in particular are being lost year by year due to expansion of agriculture. Shifting cultivation is mainly practiced around natural forests, where farmers clear an areas for cultivation (Mustafa, 1997). One of the tree species that is affected by land clearing is *B. aegyptiaca*, although it is protected by law. Efforts of the National Forest Corporation are concentrated on planting *Acacia* species. It is feared that *B. aegyptiaca* may disappear from large areas which would lead to negative environmental and social impacts. Hence, a rehabilitation program for this species is necessary. However, its success requires that information on natural regeneration potential of the tree is made available.

Material and methods

The study was conducted in the dryland of Sudan between latitude 12° and 14° N and longitude 33° and 35° E. The area is part of the central clay plain of Sudan, characterized by its cracking clay soils (Mirghani, 2007). Gully erosion stripes off the mayà (depression along river bank) from the clay plain forming lands known locally as karab, the marginal abandoned lands due to the poor and eroded soil they contain. There are several seasonal valleys that radiate from the Ethiopian Plateau. These are however, short-lived only carrying water during the peak of the rainy season. The vegetation zone in general is called *Acacia – Balanites* belt composed of a variety of tree species. The livestock in the area are camels, cattle, sheep and goat raised in traditional pastoral systems, owned by nomads and semi nomads who move within the savannah belt to rear their animals on the natural pastures which provide browse on trees and shrubs. Inhabitants practice both traditional and mechanized farming to produce sorghum (*Sorghum bicolor* L.) and sesame (*Sesame indicum* L.) Traditional agriculture is practiced by the majority of the people in this area who have limited resources to introduce heavy machines. The area of cultivation is always small, about two hectares (called "*bilad*"). Crops are produced mainly for subsistence.

A spot sampling was carried out in the field at selected sites immediately after the rainy season (October of 2015). The sites were; (a) abundant agricultural farms, where the soil is cracking clay, flat topography and traditional agriculture was practiced, (b) vicinity of the villages, the area of heavy grazing, browsing and lopping, (c) *karab*, eroded sandy loam soil lies between the water courses and flat plain, (d) valley with deposited silt and clay soils and (e) tree stands in association with *A. seyal* and *Acacia nubica* species. The diameter of study spots were 50 m and replicated three times in each location. Boundaries of the spots were marked using colored flags to prevent missing of trees or measuring trees out site the spot. All *B. aegyptiaca* plants within the spot were counted, their shoot height and diameter at ground level measured. In addition, observation on lopping and pollarding of the trees and browsing on sapling and seedlings were recorded. The status of the soil moisture in the five sites was determined in April, the driest month in the region.

Results and discussion

The monitoring of the natural regeneration of *B. aegyptiaca* carried out in the dry zone of Sudan revealed the occurrence of the species at various sizes and ages (Fig. 1). That occurrence was continuous in generation except in the valley bank and meanders. In the vicinity of villages the density of occurrence was 90 plants per plot (about 548 plants per hectare) (Fig. 2). The diameter at ground level ranged between 7.0 to 80 cm and shoot height between 1.0 to 14 m. Most of the trees ranged

between diameter 40 cm and 60 cm (Fig. 1). Absence of juveniles in spots within the vicinity of the villages even though there were big mother trees is probably due to constant fruit collection villagers. The tree is part of the food chain in the area and and an economic commodity. It could also be due to browsing and grazing on young trees during summer when fodder is scarce. Harvesting of young trees by villagers to to make fences around huts and animal enclosures could also be responsible.

The density of B. *aegyptiaca* plants on abandoned agricultural farms was 129, about 1375 in ha (Fig. 2), with diameter at ground level ranging between 5.0 to 50 cm and shoot height between 1.0 to 8.0 m. Total number of B. *aegyptiaca* seedlings counted was 270. The trees in this site were young. The results indicated that natural regeneration of *B. aegyptiaca* was dense on abandoned agricultural farms. El Amin (1990) and Goransson and Widgren (1996) also found B. *aegyptiaca* to exhibit high germination percentage (79%) on abandoned agricultural lands in Kenya. The abandoned agricultural farms used in this study were previously the natural habitats of both B. *aegyptiaca* and *A. seyal* before being converted into agricultural lands. The site is therefore still rich of soil seed bank.

In the natural forest, the total number of *B. aegyptiaca* plants were 192 (768/ha); 75 trees and 122 seedlings, with diameter at ground level ranging from 5.0 and 55 cm and shoot height ranging from 1.0 and 11 m. The experiences and studies showed that natural regeneration of *B. aegyptiaca* is successful in association with A. *seyal* on cracking clay soils. The natural regeneration of *B. aegyptiaca* was not dense as on abandoned agricultural farm because the natural forests in Sudan clay plain are swept by fires every dry season of the year. Okia (2010) reported that that natural regeneration of B. *aegyptiaca* was insufficient in Uganda due to annual bush fires set for cleaning land for agriculture practiced.

Karab soils are known of their low content of moisture and organic matter, components that determine the natural regeneration success and seedling development. Despite these conditions, there was considerable regeneration of *B. aegyptiaca* on *Karab* (Figs. 1 and 2). The diameter of seedlings and trees at ground level ranged between 5.0 to 40 cm while height ranged between 0.2 to 6.0 m. *B. aegyptiaca*, the desert date, is considered a drought resistant tree capable of growing under hard conditions of rainfall as low as 250 mm (Hall, 1991). The tap roots of the tree are so deep and facilitate plant growth even in dry conditions. Buck *et al.* (1999) stated that some plants have evolved specialized rooting systems, while others have unique leaf characteristics that allow them to withstand prolonged periods of drought.

Natural regeneration of *B. aegyptiaca* was also found on the banks of the valley or depressions (Fig. 1). The population of the trees was however less in comparison abandoned agricultural farmland, natural forest or village vicinity sites. The ratio of seedlings to trees was however comparable (Fig. 2). The number of trees was 28 and the seedlings was 29 per plot (143 and 148 per ha, respectively). The diameter at ground level of the plants ranged between 5.0 to 70 cm while height ranged between 0.2 to 6.0 m. Heavy felling and browsing were observed at this site. The valley is a good site for the growth due to the high moisture contents of the soil (Table 1), but the trees were probably subjected to felling for timber and building poles. This may explain the few number of trees found along valleys.

Moreover the site is suitable for grazing and browsing. The finding that natural regeneration of *B. aegyptiaca* was found on depressions and valleys banks agree with Badi et al (1989) who stated that the species was found growing in areas receiving less than 600 mm of water. RSCU (1992) reported that *B. aegyptiaca* species prefers valley soils while Rulangaranga (1989) observed that the tree grow well in valleys and on river banks. The range in tree diameter distribution (Fig. 1) could be attributed to the fact that farmers cut medium sized trees for building poles.

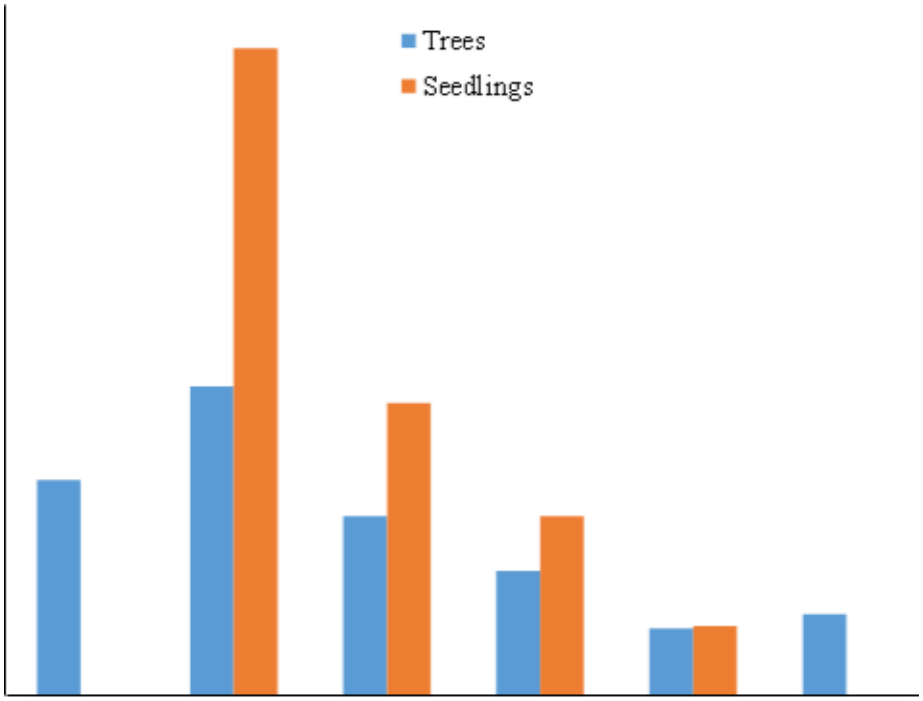

Figure 2. Stocking density of Balanites aegyptiaca trees and seedlings in 50-m-diameter plot at various growing sites.

Balanites aegyptiaca was also regenerated in the valley meanders (Fig. 1). The density of trees here was 136/ha (Fig. 2). Diameter at ground level ranged between 30 and 85cm while shoot height ranged from 5 m to 13 m. Results indicate that natural regeneration of the tree in the valleys was not continuous as in the other sites.

Absence of regeneration could be due to lack of stock seeds. Seed could have got rotten or in cases where they germinated, they would not survive as floods would submerge and kill them. The remaining trees found in this site could have grown by chance in periods of low rainfall.

Table 1. The status of the soil moisture taken at April (Dry month) at northern (A), central (B) and southern (C) parts of the zone of the study between latitude 12° and 14° N and longitude 33° and 35° E. of the dryland region of Sudan

Location	Moisture content (%)			Mean
	A	B	C	
Karab	3.6	4.8	5.0	4.5
Natural forest	6.7	4.8	4.5	5.3
Abandon agricultural farm	3.8	6.1	7.7	5.9
Vicinity of village	6.4	6.6	5.8	6. 3
Valley banks	8.3	9.8	27.2	15.1
Valley meander	10.3	13.7	37.2	20.4

Conclusion

In conclusion, *B. aegyptiaca* regenerated naturally on all sites in continuous manner except in the long valleys and vicinity of villages. The natural regeneration was ample in most of the sites, and abundant in agricultural farms. This could allow site to restock if left undisturbed. A planting programme is therefore not necessary. A sensitization programme on the diverse uses of the tree species and therefore the need for its conservation is necessary.

References

Badi, K. H., Elhouri, A. and Bayoumi, A.M. 1989. The Forests of the Sudan. Agricultural Research Council, Khartoum, Sudan. NCR press, Khartoum, Sudan. 184pp.

Bekele-Tesemma, A., Birnie, A. and Tengnas, B. 1993. Useful Trees and Shrubs for Ethiopia. Regional Soil Conservation Unit. Swedish International Development Authority: Stockholm.

Buck, L. E., Lassoie, J.P. and Fernandes, E.C.M. (eds.). 1999. Agroforestry in sustainable agricultural systems. Lewis Publishers, Boca Raton, Florida, USA. 417pp

Elamin, H.M. 1990. Trees and shrubs of the Sudan. Ithaca press Exeter: 484pp

Gagnon, J.L. 2004. Characteristics of gaps and natural regeneration in mature longleaf pine flat woods ecosystems. *Forest Ecology and Management* 187: 373-380.

Goransson, H. and Widgren, U. 1996. Direct Seeding of Balanites aegyptiaca in West Pokot District, Kenya. Working Paper No.309. Swedish University of Agricultural Sciences. 61p

Hall, J.B. 1992. Ecology of Key African Multipurpose Tree Species, Balanites aegyptiaca (Balanitaceae): The state of knowledge. *Forest Ecology and Management* 50 (1-2): 1-30

Hall, J.B. and Walker, D.H. 1991. Balanites aegyptiaca: A monograph. School of Agricultural and Forest Sciences, University of Wales, Publication No. 3: 77

Honu, Y. A. K; and Dang, Q. L. 2002. Spatial distribution and species composition of tree seeds and seedlings under the canopy of the shrub Chromolaena odorata Linn. in Ghana. *Forest Ecology and Management* (164):185–196.

Kirkpatrick, J.B., Bridle, K.L. and Dickinson, K.J. M. 2010. Decades scale vegetation change in Burned and Unburned Alpine Coniferous Heath. *Australian Journal of Botany* (58): 453-462.

McLaren, K.P. and McDonald, M. A. 2003. The effects of light and moisture on seed germination and Seedling Survival in a Tropical Dry Forest in Jamaica. *Forest Ecology and Management* 183: 61-75

Mirghani, O. 2007. Report on the field visit to Sennar and Blue Nile States, as part of the field work report, forests national corporation, Khartoum, Sudan, 54pp.

Mustafa, A.F. 1997. Regeneration of Acacia seyal forests on the dryland of the Sudan clay plain. Ph.D. Thesis, University of Helsinki. 103pp

NRC. 2008. Lost Crops of Africa: Volume III, Fruits, Development, Security and Cooperation. The National Academies Press, Washington, D.C: 236p

Okia, C.A. 2010. Balanites aegyptiaca: A resource for improving nutrition and income of Dryland Communities in Uganda. PhD Thesis, School of Environment, Natural Resources and Geography, Bangor University, Bangor, UK. 310pp.

Rulangaranga, Z.K. 1989. Some important indigenous medicinal and aromatic plants in the wild flora of Tanzania Mainland. Ministry of Lands, Natural Resources and Tourism, Forest and Beekeeping Division. Tropical Forestry Action Plan. Working Paper No. 24. Dar es Salaam, Tanzania.

SMI. 2011. Sudan the land of opportunities, fact and figures. Sudan Ministry of Information and Survey National Corporation.(SNC) : 42p

Warag, E.I., Elshiekh, A. and Elfeel, A.A. 2002. Forest genetic resource conservation in Sudan. FAO, Forest Genetic Resources No. 30.